Traditional Crop Diversity in Kumaon Himalaya of Uttarakhand State – A Case Study

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Traditional crop diversity plays an important role for the sustenance of human life. In hilly areas, climatic conditions vary from place to place and the adaptability of crops also varies. In such complex system of hill farming, number of crops and their numerous varieties are one of the main components of sustainable development. These diverse crop groups and varieties play key role in diversifying the agriculture as well as ensuring food security. The present study was focused on the adaptability of crops and their varieties (both traditional and improved) on the parameters like altitude and irrigation water in the Kumaon Himalaya. Impact of irrigation on the loss of crops diversity and selection procedures of varieties is also discussed.

Key Words: Traditional crop diversity, Sustainable development, Kumaon Himalaya

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Introduction

The Kumaon Himalaya lies between 28°29′ to 30°41′ N latitude and 79°32′ to 81°11′ E longitude. It is bordered by Kali river in the east towards Nepal and the districts Pauri and Chamoli of Garhwal region in the West. Tibet lies on the North and the Terai in the South. Physiographically, Kumaon Himalaya can be divided into the *Terai Bhaber*, the Sub-Himalayas or the *Sivaliks* or the foot hills, the lower Himalayas and the higher Himalayas. The higher Himalayan zone has a glaciated topography with many moraines, above 3000 m with ranges averaging 1850 msl and a width of above 50 km, it is highly rugged with difficult precipitius slopes. The lower Himalayas extend from West to East and are composed of granite and crystalline rocks. The sub-Himalayas or the *Sivalik* hills or the foot hills with an average height of 1225 msl is a chain of small hills. The elevation of *Bhaber* ranges between 300-600 msl from South to North.

The total geographical area of Kumaon region is 21,038 msl km of which 64.03% is under forest cover followed by crops 11.34%, meadows 4.67% and horticulture land 4.36%. The rest is under agricultural wasteland (1.95%) and wasteland (6.10%). The per capita agricultural land holding is very small (0.19 ha) in the entire Kumaon Himalaya. Around 21% area is irrigated and rest 79% is rainfed (Mehta, 2003). The farming system of the region is complex and interwoven with the natural resources like crops, livestock and forests. The great variation in topography and socio-economic factors has resulted in a diversity of farming system and mosaic situations. Agriculture still remains the mainstay of the livelihood of the local communities in the hill region. This zone is mainly inherited by *Kumaonis* and a few tribal communities, viz., *Tharus, Boxas* and *Bhotiyas* residing in far flunged areas, which are rich in their traditional cultures.

The entire Himalayan region is considered as one of the well known centres of crop diversity (Jain and Sastry, 1978; Arora, 1990; Khoshoo, 1992). A number of crops have been introduced in this region by early settlers. The introduction of new crops has created a huge diversity in crop plants, maintained through a variety of crop compositions, supported by enormous variations in the edaphic, topographic and climatic conditions (Pant, 2002). This vast wealth of crops and their numerous local varieties provide the subsistence needs to the local communities. These crops and their local varieties have become the integral part of socio-economy and culture. Growing a large number of crops and their varieties by an individual farmer is considered a symbol of respect in the region. Such kind of social respect encourages the farmers to grow and maintain more number of crops. '*Barahanaja*' (growing twelve crops together in a single field) was also once a very old tradition in the region to maintain the crop diversity. But due to demographic pressure and other socio-economic factors as well as industrial development in plains, farmers of this region have also started to adopt modern varieties and growing them by application of chemical fertilizers, pesticides, herbicides, etc. This has led to the erosion of traditional cropping system and crop genetic diversity in the region.

The Gazetteer of North-western provinces has mentioned a good account of crop plants cultivated in this Himalayan region and some varieties of paddy and wheat grown during the contemporary period (Atkinson, 1982).

A considerable amount of diversity in crops such as finger millet, wheat, paddy, etc. exists in this region. A large number of individual crop varieties were found suitable for various echo-niches (Tiwari and Das, 1995). Apart from the native crops, many useful crop species were also brought from outside by the inhabitants of the Kumaon hills. Important crops among these are foxtail millet, proso millet, buckwheat, horsegram, blackgram, greengram, cowpea, lablab bean, lentil, potato, maize, tomato, groundnut, *Cyclanthera pedata*, chilli, lai, etc. These crops have been adapted well in the climatic conditions of this region (Pant, 2002). Recently, Jardhari and Kothari (1995) and Maikhuri *et al.* (2001) have given an account of crop genetic resources of Garhwal hills and shown their concerns towards conservation of traditional crops and their landraces.

So far, very few studies have been conducted on the aspect related to availability of crops plants along the altitudinal gradients. Most of the workers have studied variation in availability of crops. Variation available in crop plants along different altitudinal zones are attributed to the factors such as environments, biodiversity conditions, temperature, amount of precipitation, soil moisture, thermal ranges, etc. (Maikhuri *et al.*, 1996a; 1996b; Palni *et al.*, 1998; Whittaker, 1970; Brookfield, 1973; Bailey, 1958 and Kawakita, 1956).

In the present study efforts have been made to have an idea about the availability of crop diversity along the altitudinal gradient and to find out the reasons of loss of crop diversity in different altitudes of the Kumaon hills.

Materials and Methods

In the present study, data were collected from primary sources with the help of a planned and structured interview schedule. Farmers/respondents were randomly selected from all the 33 development blocks of five districts (Nainital, Champawat, Almora, Bageshwar and Pithoragarh). Three villages were randomly selected from each development block. In each selected village, 5% households were randomly selected for interview. Lottery system was adopted for randomization. Thus, a total of 298 respondent farmers were sampled from 99 villages of 33 development blocks in five districts of Kumaon hills (Table 1). The respondents were interviewed thoroughly and their statements were recorded in the interview schedule. Thus, a multi-stage sampling method was employed for this study. The altitude of randomly selected villages were recorded by using Global Positioning System (GPS) instrument. During the survey of the region, observation method of data collection was also employed. A non-participant observation method was used to note down the availability of crop plants in the region.

Table 1. District-wise number of development blocks, villages and respondents of the study

S.No.	Districts	No. of development blocks	No. of villages	No. of respondent households
1	Almora	11	33	100
2	Bageshwar	3	9	32
3	Champawat	4	12	31
4	Nainital	7	21	63
5	Pithoragarh	8	24	72
	Total	33	99	298

Results and Discussions

The farming communities were dependent on a variety of crop plants available in the region for subsistence as well as to sustain their life. The number of crops grown in the entire Kumaon Himalaya were large. On the basis of their utility, these were divided into six major crop groups. There were 76 crops grown in the entire Kumaon hills. Maximum number of crops grown were under the category of vegetables (37) followed by pulses (12), cereals and pseudocereals (8), millets (7) and 6 each in oilseeds and spices (Table 2). In the cultivation system of Himalayan region, altitude plays an important role. The maximum number of crop plants (66) were being grown by the farmers in the mid-hills between 1000-2000 msl, while the minimum number of crops (39) are being grown in the higher hills above 2000 msl and followed by 44 crops in the foot hills upto 500 msl (Table 3).

Because of great variation in the topography, climatic conditions, agro-ecosystem, availability of natural resources and socio-economic and cultural dimensions in Kumaon hills, the farmers are bound to have choice to grow varieties of each crop in different agro-ecosystems to ensure production for subsistence. The number of traditional and high yielding varieties (HYVs) of major crops grown by farmers along the altitudinal gradients are of paramount importance in view of subsistence production.

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Table 2. Availability of agricultural crops in the Kumaon hills

S.No.	Crop group (Nos.)	Name of crops	Percentage (%)
1.	Cereals and Pseudocereals (08)	Amaranth (*Amaranthus frumentacea*), Amaranth (*A. oleracea*), Barley (*Hordeum vulgare*), Barley (*H. himalensis*), Buckwheat (*Fagopyrum esculentum*), Buckwheat (*F. tataricum*), Maize (*Zea mays*), Paddy (*Oryza sativa*), Wheat (*Triticum esculentum*)	10.52
2.	Millets and minor millets (07)	Barnyard millet (*Echinochloa frumentacea*), Barnyard millet (*E. crusgalii*), Finger millet (*Eleusine coracana*), Foxtail millet (*Setaria italica*), Pearl millet (*Pennisetum typhoides*), Proso millet (*Panicum miliaceum*), Sorghum (*Sorghum bicolor*)	9.22
3.	Vegetables (37)	Aerial yam (*Dioscorea bulbifera*), Bell pepper (*Capsicum annuum*), Bitter gourd (*Momordica charantia*), Bottle gourd (*Lagenaria sicerarea*), Brinjal (*Solanum melongena*), Cabbage (*Brassica oleracea* var. *capitata*), Carrot (*Daucus carota*), Cauliflower (*B. oleraceae* var. *botrytis*), Chenopod (*Chenopodium album*), Chow-chow (*Sechium edule*), Colocasia (*Colocasia esculenta*), Colocasia (*C. roxburghii*), Cucumber (*Cucumis sativus*), Elephant ear cabbage (*Brassica juncea var. rugosa*), Elephant yam (*Amorphophalus campanulatus*), Faba bean (*Vicia faba*), Fenugreek (*Trigonella foenumgraecum*), French bean (*Phaseolus vulgaris*), Jackfruit (*Artocarpus hetrerophyllus*), Lablab bean (*Lablab purpureus*), Lepidium (*Lepidium sativa*), Okra (*Abelmoschus esculentus*), Onion (*Allium cepa*), Potato (*Solanum tuberosum*), Pumpkin (*Cucurbita moschata*), Pumpkin (*C. peppo*), Radish (*Raphanus sativus*), Ridge gourd (*Luffa acutangula*), Snake gourd (*Trichosanthes anguina*), Spinach (*Spinacea oleracea*), Sponge gourd (*Lufa cylindrica*), Sweet gourd (*Cyclenthera pedata*), Tomato (*Lycopersicon esculentum*), Tree tomato (*Cyphomendra betacea*), Turnip (*Brassica rapa*), Waxgourd (*Benincasa hispida*), Yam (*Dioscorea sagittala*)	48.69
4.	Pulses (12)	Blackgram (*Vigna mungo*), Chickpea (*Cicer arietinum*), Cowpea (*Vigna anguiculata*), Green gram (*V. radiata*), Horsegram (*Macrotyloma uniflorum*), Lentil (*Lens culinaris*), Pea (*Pisum sativum*), Pea (*P. sativum* var. *arvens*), Pigeon pea (*Cajanus cajan*), Rice bean (*Vigna umbellata*), Soybean (*Glycine max*), Soybean (*Glycine max*)	15.79
5.	Oilseeds (06)	Brown sarson (*Brassica juncea* var. *brown sarson*), Groundnut (*Arachis hypogaea*), Linseed (*Linum usitatissimum*), Perilla (*Perilla frutescens*), Sesame (*Sesamum indicum*), Yellow sarson (*Brassica juncea* var. *yellow sarson*)	7.89
6.	Spices and condiments (06)	Chilli (*Capsicum annuum*), Coriander (*Coriandrum sativum*), Garlic (*Allium sativum*), Ginger (*Zingiber officinalis*), Hemp (*Cannabis sativa*), Turmeric (*Curcuma longa*)	7.89
	Total (76)		100.00

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Table 3. Altitude-wise crops grown by farmers of Kumaon for subsistence

S.No.	Crop groups	Altitude-wise No. of crops grown (Altitude in metres)				
		Up to 500	500-1000	1000-1500	1500-2000	2000-2500
1.	Cereals and pseudocereals	4	4	4	6	7
2.	Millets and minor millets	1	5	5	6	3
3.	Vegetables	26	33	36	32	17
4.	Pulses	5	9	9	9	5
5.	Oilseeds	3	6	6	6	2
6.	Spices and condiments	5	6	6	6	5
	Total number of crops	44	63	66	65	39

The data revealed that the farmers in the Kumaon region were still growing a large number of traditional crops in their land holdings. The number of traditional crops were more in comparison to high yielding varieties. The farmers of lower altitude areas were mostly dependent upon high yielding varieties. With the increasing elevation, the number of traditional crops and their varieties also increase up to a certain altitude. In the cereal group, the number of crops were few, but number of varieties in a crop were quite large. In case of paddy, more than one hundred landraces varieties are grown by farmers (Table 4 and 5). Likewise, wheat and finger millet also had many landraces/varieties under cultivation. In mid-hills also, number of crops and folk varieties of these crops were more. In the lower and higher hills, less number of traditional varieties were grown by the farmers in comparison to mid-hills. However, high yielding varieties were more in lower hills, followed by mid and

Table 4. Altitude-wise availability of number of traditional/folk varieties of some major crops in Kumaon hills

S.No.	Crops	No. of folk varieties at different altitudes (m asl)				
		Up to 500	500-1000	1000-1500	1500-2000	2000-3000
1.	Paddy (*Oryza sativa* L.)	0	18	61	52	27
2.	Wheat (*Triticum aestivum* L.)	0	5	10	14	13
3.	Finger millet (*Eleusine coracana* (L). Gaerth.)	0	5	15	15	15
4.	Maize (*Zea mays* L.)	0	1	4	5	2
5.	Barnyard millet (*Echinochloa frumentacea* L.)	1	2	3	3	3
6.	Barley (*Hordeum vulgare* L.)	1	1	1	3	3
7.	Cowpea (*Vigna unguiculata* L.)	—	2	3	5	3
8.	Horsegram (*Macrotyloma uniflorum* Lam.)	—	2	2	2	2
9.	Black seeded soybean (*Glycine max* (L.) Merill)	—	2	4	5	2
10.	Black gram (*Vigna mungo* (L.) Hepper)	1	1	2	2	2
11.	French bean (*Phaseolus vulgaris* L.)	—	2	3	4	4
12.	Pea (*Pisum sativum* L.)	0	2	2	3	1
13.	Lentil (*Lens culinaris* Medikus)	—	2	2	3	—
14.	Brinjal (*Solanum melongena* L.)	0	2	2	2	2
15.	Bottle gourd (*Lagenaria sicerarea* Molina (Standl. Ex.))	0	3	3	3	—
16.	Pumpkin (*Cucurbita moschata* Duch ex. Poir)	1	1	2	3	1
17.	Chillies (*Capsicum annuum* L.)	0	1	3	3	—
18.	Ridge gourd (*Luffa acutangula* (L.) Roxb.)	1	2	2	2	2
19.	Mustard (*Brassica juncea* L.)	2	2	2	2	2
20.	Potato (*Solanum tuberosum* L.)	—	2	2	3	1
	Total	7	58	128	134	85

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Table 5. Traditional varieties of major crops grown in Kumaon Himalaya

Crop	Name of traditional varieties
Paddy (*Oryza sativa* L.)	Akadi, Anjan, Askotia, Bagudhan, Bhatusanw, Bhadgar, Bhuria, Binduli, Bakul, Bakudhan, Bamkua, Banpas, Bantiya, Basmati, Boran, Chamadia, Chauria, Chhotia/Chhoti, Chinbhuri, Dalbadal, Dangazai, Dan naulia, Dansal, Dhania, Dhang, Dhaulia, Dotiyali, Dudh, Famkua, Gadalu, Gajazi, Gazala, Ghesu, Gid, Goldhan, Hat, Hayal, Jamai/Jamal, Janoli, Jawaan, Jhadua, Jhukai, Jiruli, Jolia, Jorhat, Jungledhan, Jungloi, Jyoli, Kaladhan, Kalasontu, Kalthunia, Kalisal, Kalijamali, Kalpara, Kapkoti, Kashmiri, Katyuri, Khardudh, Khasiyara, Khozia, Kirniti, Laldhan, Lali, Lahangi, Lathait, Lohin, Madguri, Maila, Makhur, Maltiya, Mangraj, Musmad, Masur, Nalu, Nandani, Nandhan, Naulia, Nauldudh, Paktauli, Parange, Parvati, Patoli, Pingau, Pyolia, Rajdhan, Rajmati, Rajula, Rakesia, Ramgarhi, Ram manua, Ram Sita, Rati, Rokhiyal, Sal, Sanwdhan, Simanjari, Silk, Sirmodia, Sokia, Sita, Sonti, Sontu, Sudia, Sunkhar, Suntola, Taoli, Teli, Thai, Thapachini, Thulbasmati, Timilia, Ud, Uskar.
Wheat (*Triticum aestivum* L.)	Bhati, Chanosi, Chotia safed, Chyud, Dapati, Dhang, Dhaulia, Dudgyun, Doldakhani, Dudh, Geruwa, Intor, Jhusia, Kanyari, Kavjhusi, Lalgeyun, Lalnoi, Mangraje, Munar, Naulia, Pothi, Rata, Syatgyun.
Finger millet (*Eleusine coracana* (L.) Gaerth.)	Adagdali, Ageti, Bagadi, Basuli, Bhati, Bhuria, Chhahmasi, Chhapariya, Chhiptalbhati, Dhuni, Dotiyali, Garhwali, Golmanua, Gunari, Jhakarua, Jhumaria, Kalamandua, Kataki, Kavnoi, Kodi, Kodya, Kunwi, Lalmanua, Lampadaliya, Lohariya, Lumadia, Maneri, Mutkiya, Nangihuni, Parvati, Pichheti, Putkiya, Pyoli, Sodia, Surai, Timasia.
Maize (*Zea mays* L.)	Angulighoga, Dhawal, Gorakhamakka, Lal, Pilimakki, Murali, Timasia.
Barley (*Hordeum vulgare*)	Kala jau, Safed jau, Uwa (naked)
Barnyard millet (*Echinochloa frumentacea* L.)	Bada, Chhahmasia, Chhotia, Ganaru, Manaru, Jhakru
Cowpea (*Vigna unguiculata* L.)	Kala, Safed, Lal, Chitkavari, Bhara.
Horsegram (*Macrotyloma uniflorum* Lam.)	Lal, Dhaul, Bhura, Kala
Black seeded soybean (*Glycine max* (L.) Meritl.)	Kala chhota, Kalabada, Lal, Bhura, Hara
Black gram (*Vigna mungo* (L.) Hepper.)	Bhura, Kala, Hara
French bean (*Phaseolus vulgaris* L.)	Lal, Safed, Bhura, Kala, Chitkavare
Pea (*Pisum sativum* L.)\	Safed, Cream, Bhure
Lentil (*Lens culinaris* Medikus)	Kala, Bhura, Cream
Brinal (*Solanum melongena* L.)	Lamba kala, Lamba hara, Gole
Bottle gourd (*Lagenaria sicerarea* Molina)	Lamba, Gole, Madhyam chitkavara
Pumpkin (*Cucurbita moschata* Duch ex. Poir)	Lamba kadu, Golkadu, Nepali kadu
Chillies (*Capsicum annuum* L.)	Patali lal, Pili, Chhotigole
Ridge gourd (*Luffa acutangula* (L.) Roxb.)	Lamsi torai, Chhoti torai
Mustard (*Brassica juncea* L.)	Kali sarson, Pili sarson
Potato (*Solanum tuberosum* L.)	Gwaldam local, Lal alu, Safed alu, Naming, Dharchula local, Pahari gole (Gola)

high hills. Overlapping of crop varieties in different altitudinal zones was also observed (Table 6).

The study indicated that cultivation system in the Kumaon hills is dominated by traditional crop varieties. In all, 76.85% farmers were growing the age old folk varieties, while 23.15% farmers were growing high yielding varieties (Table 7). It is worth mentioning that the percentage of cultivation of traditional crop varieties was the lowest (30%) in the lower altitudinal zone (upto 500 m) and highest (91.25%) in the high altitudinal zone (2000-3000 m). With the increase in altitude, the number of traditional crop varieties also increased (Table 7). Contrary to this, the reverse pattern was observed in the use of HYVs. There was a high degree of positive correlation between the altitude and cultivation of traditional crop varieties (Table 7).

In the traditional agricultural system, seeds are kept and maintained by farmers themselves for next crop season, failing which, they arrange them from other sources. In the study area, the sources of seeds were local farmers and relatives, local market and government agencies (Table 8). It was evident that a large number of farmers (74.16%), still arranging the seeds from local/ neighbouring farmers and relatives. Farmers also depended on local market for seeds as 17.12% seeds were procured from market sources. Government agencies had a very little role (8.72%) in distribution of seeds to the farmers in the region.

It is evident from Table 9 that with the increase in altitude, the irrigation facilities decreased. The availability of irrigation water varied, significantly ranging from 5% (>2000 msl) to 80% in the lower part of foot hills (upto 500 msl). Accordingly, introduction and farming of HYVs decreased in the entire hill zone. In the foot hills upto 500 m asl 80% HYVs and above 2000 msl 8.75% HYVs were big. A negative correlation was observed between the altitude and availability of irrigation water. The same correlation was also seen between altitude and cultivation of HYVs. There was a high degree of positive correlation between availability of irrigation water and cultivation of HYVs.

In terms of loss of agrobiodiversity, it was evident that the availability of irrigation water forced the farmers to replace the traditional crop varieties with the HYVs. The magnitude of loss of agrobiodiversity from the lower altitude to higher altitudes is shown in Table 9).

In the Kumaon hills, farmers inhabiting in different altitudinal zones cultivated different crops. The number of crops also varied with the increase of elevation. Maximum number of crops were grown in the elevation zone between 500-1500 m asl. The variation in number of crops may be because of different factors such as environmental, bio-climatic, economic and cultural conditions (Maikhuri *et al.*, 1996a, 1996b and Palni *et al.*, 1998). Distribution of each species depends on its mode of genetic combination, physiology and life cycle pattern and its relationships to both physical environment and interaction with other species. Hence, the distribution of any two species may not be similar. The broadly overlapping and scattered centres of plant population along a gradient imply that most communities integrate continuously along environmental gradients, rather than forming distinct, clearly separate zones (Whittaker, 1978).

In the present study, the information was categorized as per the crop, viz., cereals and pseudocereals, millet and minor millets, vegetables, pulses, oilseeds and spices and condiments. The vegetable group contained largest number of crops followed by pulses, cereals and pseudocereals, respectively (Table 2). Further, the data were categorized according to different elevations. Maximum number of crops were grown in mid-hill zone between 1000-2000 msl (Table 3).

Mid-hills are the repository of crops and their numerous folk varieties, because of availability of water for irrigation as well as rainfall. In the rainfed condition, a large number of crops and varieties were grown in mixed cropping pattern in order to facilitate food security of farm households. Climatically, the mid-hills are neither too warm nor too cold, which suits to cultivation of more number of crops as compared to high hills and lower hills.

Other studies also supported our findings regarding availability of crop/plant species in different altitudinal zones attributed to micro-level environment and bio-climatic variables (temperature, precipitation, soil, moisture, etc.). The thermal ranges affect crop ranges in the hilly slopes (Brookfield; 1973; Bailey, 1958; 1960; 1977; Kawakita, 1956).

At present, traditional as well as improved varieties are under cultivation in Kumaon hills. Maximum number of traditional varieties are being grown in mid-hills between an altitude of 1000 and 2000 msl (Table 4). However, high yielding varieties (HYVs) were also grown by the farmers, but these were restricted to lower hills and valley zones only because of availability of irrigation water.

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Table 6. Number of high yielding varieties grown in different altitudes in Kumaon hills

S.No.	Crops	No. of HYVs at different altitudes (m amsl)				
		Upto 500	500-1000	1000-1500	1500-2000	2000-3000
1	Paddy (*Oryza sativa* L.)	7	9	7	4	0
2	Wheat (*Triticum aestivum* L.)	5	4	3	0	0
3	Maize (*Zea mays* L.)	2	0	0	0	0
4	Soybean (*Glycine max* (L.) Merill.)	2	2	1	1	1
5	Cowpea (*Vigna unguiculata* L.)	2	2	0	0	0
6	Black seeded soybean (*Glycine max* (L.) Merill)	1	1	0	0	0
7	Lentil (*Lens culinaris* Medikus)	1	1	0	0	0
8	Brinjal (*Solanum melongena* L.)	1	1	0	0	0
9	Chillies (*Capsicum annuum* L.)	1	1	0	0	0
10	Okra (*Abelmoschus esculentus* L. Moench.)	2	2	0	0	0
11	Potato (*Solanum tuberosum* L.)	0	0	0	2	2
	Total	24	23	11	7	3

Table 7. Types of varieties grown by the respondent farmers in different altitudinal zones of Kumaon hills

S.No.	Altitude in metres	Type of varieties grown by farmers			
		Traditional varieties		High yielding varieties (HYVs)	
		No. of farmers	Percentage (%)	No. of farmers	Percentage (%)
1	Upto 500	1.5	30.00	3.5	70.00
2	500-1000	18	45.00	22	55.00
3	1000-1500	64	70.33	27	29.67
4	1500-2000	109	90.17	13	9.83
5	2000 and above	36.5	91.25	3.5	8.75
	Total	229	76.85	69	23.15

Calculated chi-square value is 39.165 and table value at degree of freedom (d.f.) (r) = 4 is 9.488 at 5% level. Calculated value is > table value. Hence, the data is highly significant.

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Table 8. Sources of seed material of the local farming communities of Kumaon Himalaya

S.No.	Sources of seed material	No. of farmers	Percentage (%)
1.	Local farmers and relatives	221	74.16
2.	Local market	51	17.12
3.	Government agencies	26	8.72
	Total	298	100.00

Table 9. Availability of irrigation water and cultivation of high yielding varieties (HYVs) in different altitudinal gradients in Kumaon hills

Altitudinal gradients (m)	Availability of irrigation water (%)	Cultivation of HYVs (%)
Upto 500	80.00	70.00
500-1000	70.27	55.00
1000-1500	31.91	29.67
1500-2000	9.84	9.83
2000-2500	5.00	8.75

Easy accessibility to improved and new technologies has changed the farming system from subsistence based to market oriented. The linking of rural areas with each other by the road transport also led to the higher degree of commercial farming. The cultivation of high value cash crops replaced low value subsistence crop cultivation in most of the areas. The subsistence crop farming continued only in marginal land on steep slopes, where irrigation facility was meagerly available (Jodha 1992). In this region, where irrigation facility is available, the farmers of villages of nearby markets grow the crops as per the needs of market, especially improved vegetables, by using external inputs. Hence, in lower altitude areas, the availability of irrigation and transport facilities encouraged the farmers to grow HYVs as compared to high altitude areas, where they faced adverse conditions and were bound to dwell upon subsistence agriculture containing good crop diversity of traditional varieties (Tables 7 and 9).

A steady shift from traditional agro-ecosystem to modern agro-ecosystem because of edaphic, topographic and climatic factors coupled with the tremendous selection pressure over centuries old cultivation system resulted into immense variations in traditional varieties suited to a particular area (Arora and Nayar, 1984). These varieties withstood the rigours of time, escaped the pressure of insect, pest, diseases and tolerated the adverse climatic conditions. They also possessed the desired agronomic

and genetic traits required to develop resistant varieties (Alteri, 1998; Anonymous, 1989; MC Neely *et al.*, 1990). However, the farmers of mid and high hilly areas were bound to cultivate maximum number of crops and their old traditional varieties. Change in traditional agro-ecosystem into modern agro-ecosystem and loss of agro-biodiversity was evident in the Himalayan region.

For traditional knowledge, women folk, old aged and illiterate people acquired good knowledge of crop varieties. In low input agriculture system, women had traditionally been the managers of germplasm (Sateesh, 1995). It was also observed in the hilly areas of Kumaon (Tiwari *et al.*, 1995). Women folk also played an important role in dissemination of the varieties (Ashby *et al.*, 1990). In ancient societies, old aged persons used to get respect because of knowledge, experience and legendary lore (Harlan, 1992). Due to long experience of cultivation of old traditional crops older generation acquired a lot of knowledge in comparison to younger generations. Modern literate society considers agriculture is meant for illiterate people. They are interested to seek off-farm jobs (Maikhuri *et al.*, 1996 a; Mulk, 1992).

The present study revealed that a large number of crops were grown in the Kumaon region. The adaptability of crops varied along the altitudinal zones. Farming communities were growing a large number of crops to fulfill their subsistence needs. Apart from a large number of crops, a large number of varieties of these crops were being grown in different types of soils, moisture regimes, eco-niches, altitudes, etc. Most of the crops grown in the entire hill region were traditional old varieties. These were very much suitable for production in adverse conditions also. These traditional crop plants and their varieties formed the base of subsistence for local inhabitants as well as for the sustainability in the production system. The cultivation of traditional crops and their varieties were the tools for on-farm/*in-situ* conservation of plant genetic resources in the region. It is noteworthy that the modernization of agriculture in the Central Himalaya is at the cost of the cultural heritage, which was preserved for centuries. In the valley areas, with availability of irrigation facilities, the farmers started cultivation of HYVs and pushed the traditional crops (millets, minor millets, coarse grain legumes, pseudocereals, etc.) towards marginal lands. With the marginalization and abandoning cultivation of traditional crops, farmers lost the unique wealth in the form of traditional knowledge associated with the cultivation of obsolete crops and varieties. In addition, the region also lost the crop diversity as the farmers replaced their traditional varieties by growing HYVs. In the mid and high altitudes where crops are grown under natural precipitation regime, farmers should be encouraged to grow traditional cultivars. Keeping in view the natural and socioeconomic conditions, multi-disciplinary approach should be adopted to develop a viable farming system which could provide the food and economic security to the people of the region by using the local resources.

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